Lecture 26: Equivalent Input Noise

- Announcements:
- HW#7 online and due Friday, May 6
  - No need to turn in HW#7; we'll just give you time to do it, then release solutions on May 6
  - You will need to understand this material for the Final Exam, so it's in your best interest to do the homework
- Project slide #3 due Friday, April 29, at 8 a.m.
- Project outbrief sign up sheet will be on Prof. Nguyen's office door tonight
  - Slots will be on Thursday and Friday of next week
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- Reading: Senturia Chpt. 16
- Lecture Topics:
  - Minimum Detectable Signal
  - Noise
    - Circuit Noise Calculations
    - Noise Sources
    - Equivalent Input-Referred Noise
  - Gyro MDS
    - Equivalent Noise Circuit
    - Example ARW Determination
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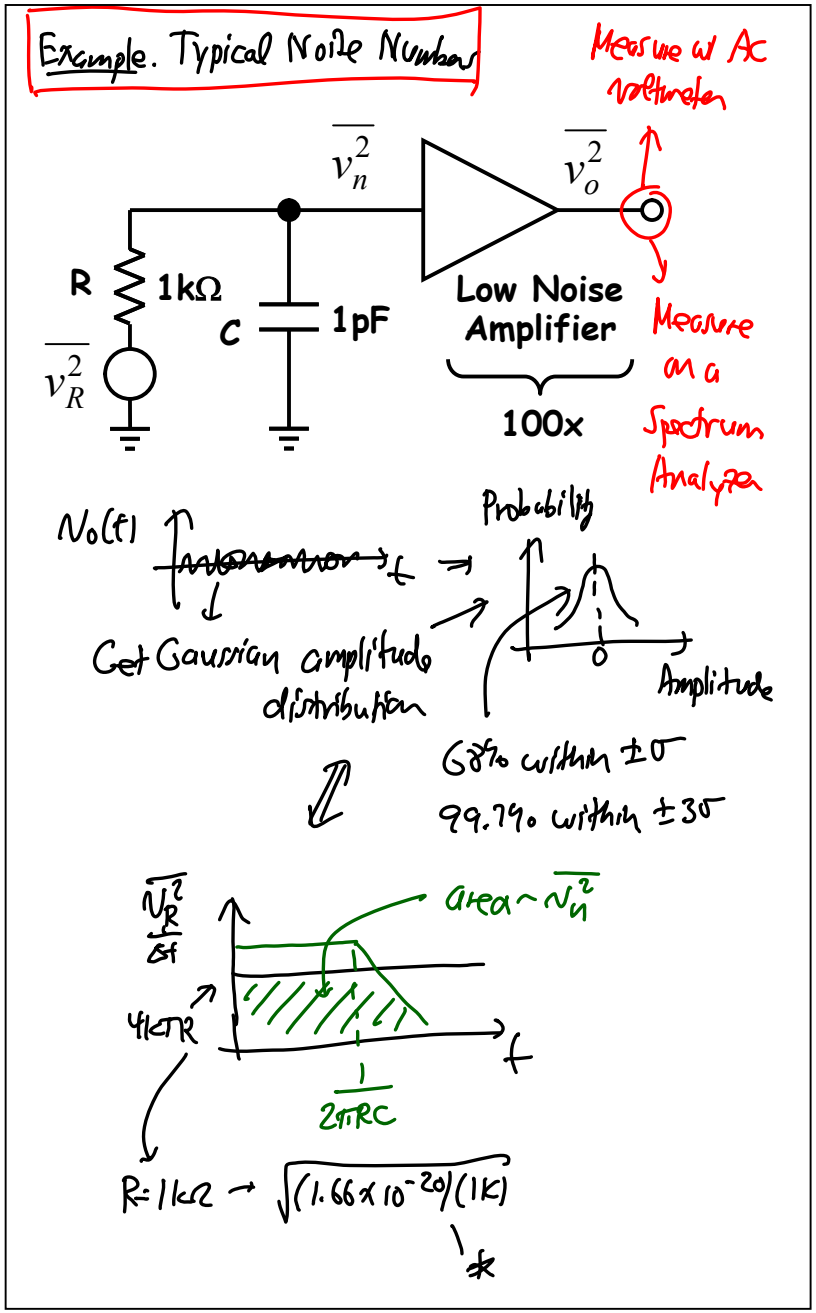
- Last Time:
- Noise & noise calculations, ending up in Module 17, slide 29
- Now, continue with input referred noise



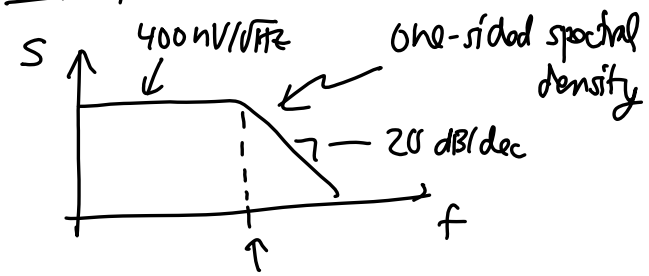
* — 1kΩ: $4nV/\sqrt{Hz}$ (for every 1K of R)

1pF: $\sqrt{\frac{kT}{C}} = 64\mu V_{rms}$

Case: AC Voltmeter →

$\sqrt{\overline{N_o^2}} = (100)(64\mu V_{rms}) = 6.4mV_{rms}$

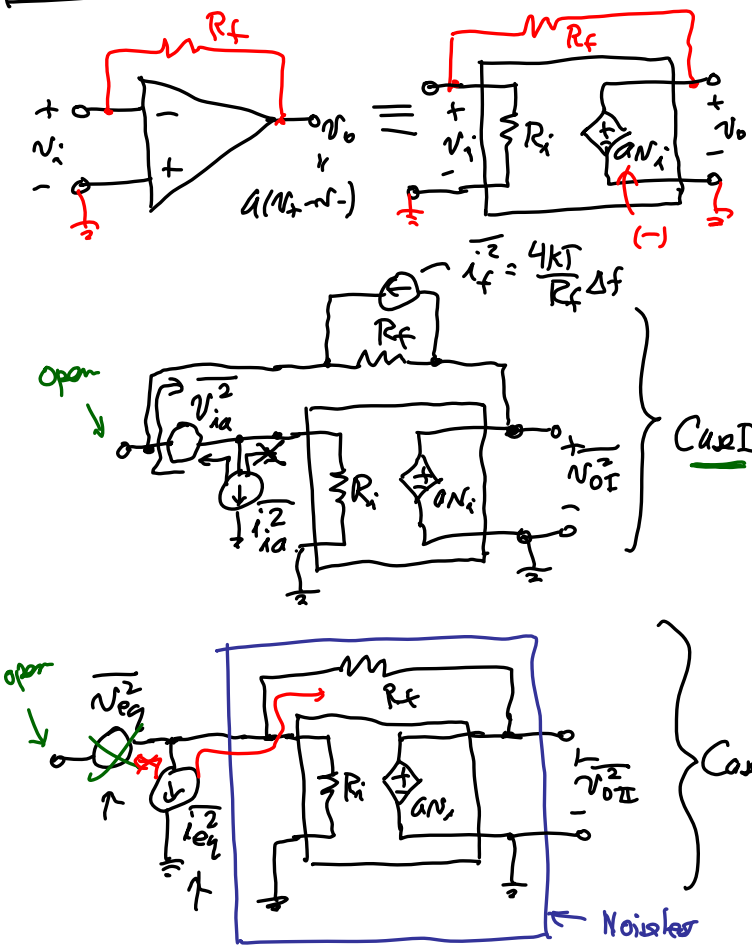
Case: Spectrum Analyzer



$\frac{1}{2\pi(1K)(1p)} = 60MHz$

- Go through Module 17, slides 23-29
- Actually, went quickly through quite a few slides from Module 17, since it seems not many actually finished watching the video from last Thursday

Example: Trans R Amplifier Input-Referred Noise



Input-Referred Current Noise:

Open inputs; equate output voltage noise for Case I & Case II → solve for $\overline{i_{eq}^2}$

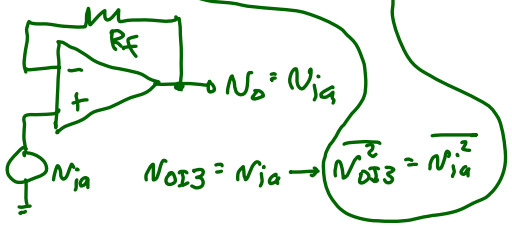
Case I: (use superposition)

$\overline{i_{ia}^2}$: $v_{oI1} = i_{ia} R_f \rightarrow \overline{v_{oI1}^2} = \overline{i_{ia}^2} R_f^2$

$\overline{i_f^2}$: $v_{oI2} = i_f R_f \rightarrow \overline{v_{oI2}^2} = \overline{i_f^2} R_f^2$

→ power @ output generated by noise sources

$\overline{v_{ia}^2}$:



$v_{oI3} = v_{ia} \rightarrow \overline{v_{oI3}^2} = \overline{v_{ia}^2}$

$\therefore \overline{v_{oI}^2} = \overline{i_{ia}^2} R_f^2 + \overline{i_f^2} R_f^2 + \overline{v_{ia}^2}$

Case II: $v_{oII} = i_{eq} R_f \rightarrow \overline{v_{oII}^2} = \overline{i_{eq}^2} R_f^2$

Now, set $\overline{v_{oI}^2} = \overline{v_{oII}^2}$:

$$\overline{i_{eq}^2} = \overline{i_{ia}^2} + \overline{i_f^2} + \frac{\overline{v_{ia}^2}}{R_f^2}$$